

A 10-minute Comprehensive Liver MRI Protocol at 3.0T: Application of Novel Breath-hold Sequences and a Simultaneous Scanning and Reconstruction Algorithm

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Purpose and Introduction Compared to abdominal CT, current liver MRI exams are relatively long (often approx. 30 minutes vs. <5 min for CT). Over the past decade, we have seen a surge of newer and faster MR sequences, however, this did not result in shorter exam times. The introduction of clinical 3.0T systems with higher SNR, multi-channel phased array coils, parallel imaging techniques, parallel RF transmission, novel sequences¹⁻³, and faster computers currently allow us to perform real-time scanning and reconstruction. These developments led us to believe that a comprehensive liver MRI should be possible in a much shorter exam time. Decreasing imaging time should affect patient compliance and result in a more economic use of MRI machines, while providing a time-competitive alternative to body CT examinations. Therefore, the purpose of this study was to assess the feasibility of a 10-minute comprehensive liver MR imaging protocol at 3.0T based on the application of single-shot turbo spin-echo (SSTSE), modified Dixon (mDIXON), diffusion-weighted imaging (DWI) and a simultaneous scanning and reconstruction algorithm.

Materials and Methods During a one-month period, 16 consecutive patients (8 males and 8 females; mean age, 56.3 years, age range 37-84) were examined based on a simultaneous scanning and reconstruction MRI method optimized to assess liver lesions. The method consisted of multiple breath hold sequences, including axial and coronal T2-weighted single-shot fast spin-echo imaging, diffusion weighted imaging (b-values of 0, 20, and 500), pre-contrast axial 2-point mDIXON (yielding in-phase, out-of-phase, water, and fat images), arterial (timed based on the bolus track) and delayed phase gadolinium-enhanced images (axial and coronal) acquired based on the water-image from the mDixon sequence. The total MRI scan time was measured by recording the start and endpoint of the exam as reported by the MRI system on the images. The overall and per-sequence image quality was ranked by an experienced MR radiologist on a scale from 1 to 5 (5 being excellent).

Results MR imaging exams were successfully performed in all patients (Figure 1). The mean in-room time to conduct the entire MR imaging study was 10±2 minutes (range, 8-12 minutes). 12 of 16 (75%) patients were scanned in ≤ 10 minutes. The remaining 4 patients had exam times of ≤ 12 minutes. For the 4 patients above 10 minutes, the cause of the increased exam time was patient-related (3 cases), and MR protocol-related (1 case). The overall image quality score was 3.8 ± 0.9. The per-sequence image quality varied between 2 and 5 (DWI was the lowest, 2, and the arterial phase was the highest, 5).

Discussion and Conclusion Patient compliance was excellent, which was likely due to short exam times. The SSTSE sequences had the longest imaging times, due to SAR-intensive nature of these sequences. This sequence needs further improvement in order to reduce scan times. Combined with additional modifications such as higher parallel imaging factors and parallel RF transmission, the current protocol should become even shorter. Based on the current study, a 10-minutes comprehensive liver MRI protocol at 3.0T is feasible by the application of novel breath-hold sequences and a simultaneous scanning and reconstruction algorithm.

References ¹W. T. Dixon, Radiology, 153:189-194 (1984), ²H. Eggers, B. Brendel, G. Herigault, Proc. Intl. Soc. Mag. Reson. Med., 17:2705 (2009) ³W.A. Willinek, J. Gieseke, G.M. Kukuk, et al. Radiology 256:966-975 (2010)

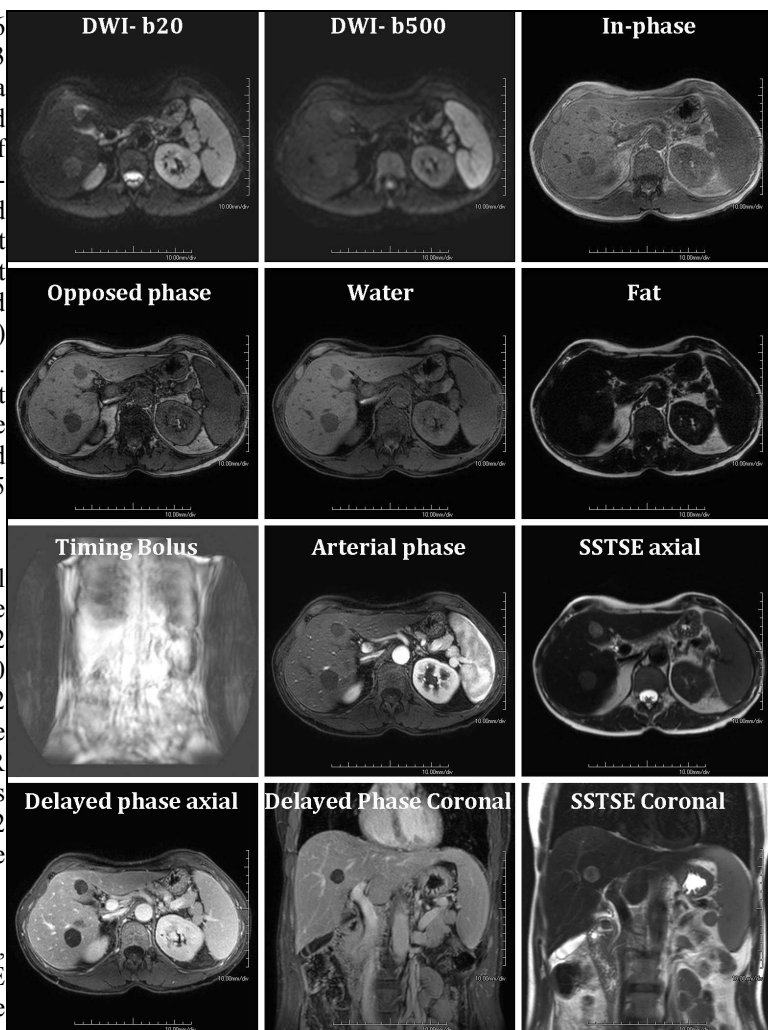


Figure 1. A typical example of the sequences and the order in which these were performed in our study.